

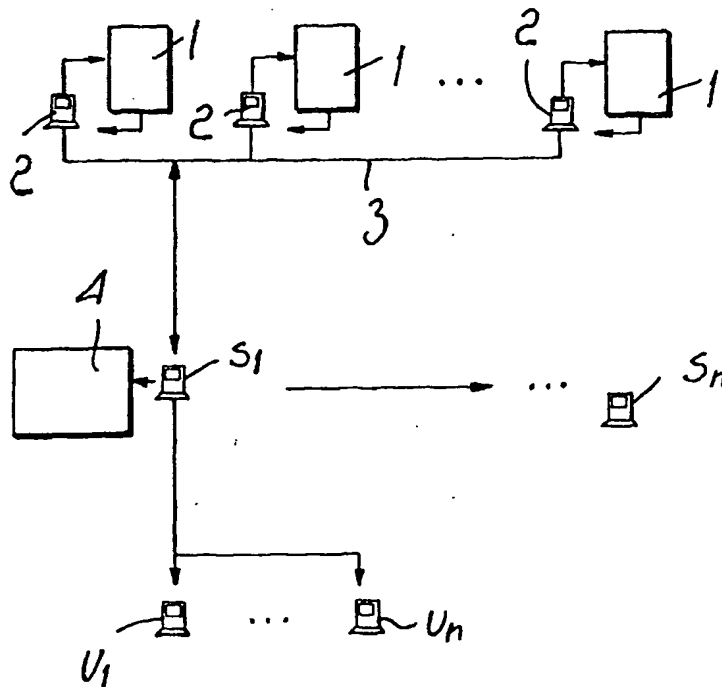


## INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

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**(54) Title:** DEVICE AND PROCESS FOR REMOTE CONTROL OF TELESCOPES FOR ASTRONOMICAL OBSERVATIONS**(57) Abstract**

A device for remote control of telescopes for astronomical observations, comprising one or more telescopes, each controlled by a respective computer, at least one server to which the computers are connected by means of a local area network, the server being connected to a wide-area data network in order to receive requests from users to access the one or more telescopes, the server decoding the requests and transmitting to the control computers the instructions required to actuate the telescopes according to the requirements of the users.



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## DEVICE AND PROCESS FOR REMOTE CONTROL OF TELESCOPES FOR ASTRONOMICAL OBSERVATIONS

### Technical Field

The present invention relates to a device and a process for remote control  
5 of telescopes for astronomical observations.

### Background Art

It is known that astronomy is a science which is becoming increasingly  
popular worldwide and is also the starting point for the development of  
more in-depth studies related to biology, physics, medicine etcetera.

10 The use of professional telescopes is currently severely restricted to a  
limited number of individuals and therefore cannot be accessed by the  
general public, which is accordingly forced to purchase a personal  
telescope, which in most cases is of the amateur type due to high costs, and  
to reach a suitable location to install the telescope and perform the  
15 observations.

Accordingly, the travel of the user to the observation site and the  
transport of the telescope entail the need to have time and a means of  
transport available.

Moreover, when the user reaches the observation site, atmospheric  
20 conditions are not always ideal for observation and therefore in this case the  
trip is useless.

All these drawbacks have limited, up to now, the activity of amateur  
astronomers and have also certainly limited the number of people who  
would be potentially interested in becoming acquainted with astronomy.

25 The fact should also be noted that anyone performing astronomical  
observations is usually attracted by the possibility to take astronomical  
photographs and/or moving pictures with electronic devices.

This possibility is therefore also closely dependent on finding the  
optimum atmospheric conditions for taking said photographs.

### Disclosure of the Invention

The aim of the present invention is to provide a device and a process for remote control of telescopes for astronomical observations which allows to substantially eliminate the need for the user to purchase a personal  
5 telescope.

Within the scope of this aim, an object of the present invention is to provide a device and a process for remote control of telescopes for astronomical observations which allows the user to substantially eliminate the need to travel to a suitable observation site carrying his own telescope  
10 with him.

Another object of the present invention is to provide a device and a process for remote control of telescopes for astronomical observations which allows the user to take astronomical photographs and/or videos of high quality without having to purchase expensive equipment.

15 Another object of the present invention is to provide a device and a process for remote control of telescopes for astronomical observations which allows to access the world of astronomical observations by means of a conventional PC.

Another object of the present invention is to provide a device and a  
20 process for remote control of telescopes for astronomical observations which allows to control a telescope remotely and entirely automatically even for operations such as image focusing, precision in tracking celestial bodies and sighting.

Another object of the present invention is to provide a device and a  
25 process for remote control of telescopes for astronomical observations which are highly reliable, relatively easy to provide and at competitive costs.

This aim, these objects and others which will become apparent hereinafter are achieved by a device for remote control of telescopes for  
30 astronomical observations, characterized in that it comprises one or more

telescopes, each controlled by a respective computer, at least one server to which said computers are connected by means of a local area network, said server being connected to a wide-area data network in order to receive requests from users to access said one or more telescopes, said server  
5 decoding said requests and transmitting to said control computers the instructions required to actuate said telescopes according to the requirements of the users.

This aim, these objects and others which will become apparent hereinafter are also achieved by a process for remote control of telescopes  
10 for astronomical observations, characterized in that it comprises the steps of:

    sending to a server, by means of a wide-area data network, a request to use a remote telescope;

    waiting for said server to enable said telescope; and

15     waiting for the response of said telescope, in terms of images, photographs and the like, from said server.

#### Brief Description of the Drawings

Further characteristics and advantages of the invention will become apparent from the description of a preferred but not exclusive embodiment  
20 of the device and process according to the invention, illustrated only by way of non-limitative example in the accompanying drawings, wherein:

    Figure 1 is a block diagram of the control device according to the present invention;

    Figure 2 is another block diagram of a portion of the control device  
25 according to the present invention;

    Figure 3 is a block diagram of the control process provided according to the present invention;

    Figure 4 is a more detailed block diagram of a portion of the diagram of Figure 3;

30     Figure 5 is a schematic view of a telescope adapted for using the process

according to the present invention.

#### Ways of carrying out the Invention

With reference to the above figures, the control device according to the present invention comprises one or more telescopes 1 located at sites which are geographically adapted for astronomical observation, such as for example mountains, hills, and the like, and with which a respective computer, for example a PC 2, is associated. The PCs 2 are mutually connected by means of a local area network 3 (known as LAN) and are interfaced with at least one server  $S_1...S_n$ , which also has a database which contains images and information that the user can access.

The servers  $S_1...S_n$  can furthermore be connected to an actual astronomic observatory 4, accordingly allowing users to connect not only to the various telescopes 1 but also to the observatory; in this case it is not possible to directly control the telescopes by means of computers 2, but one can merely receive images and any other data from the observatory 4.

At this point, a plurality of users  $U_1...U_n$  can connect to the various servers and can therefore individually control the telescopes 1 by means of a control software loaded in the computers 2.

The above-described system is shown more clearly in Figure 2, in which the server  $S_1$  is connected, by means of a network 4, for example an Ethernet-type LAN, to a node 5 which acts as a hub for the local area networks 3 that connect the control computers 2 of the telescopes 1.

Figure 2 also illustrates the connection between an image acquisition device 10 of the CCD type, associated with the telescope 1, and the respective computer 2.

The connection between the telescope 1 and the computer 2 occurs for example by means of an RS232 serial network or the like, whereas the connection between the CCD image acquisition devices is of the SCSI type.

The server  $S_1$  is connected, by means of a global area network 11, to a wide-area data network such for example the Internet.

Figure 3 is a detail view of a block diagram of the main software program for managing the computers 2 for controlling the individual telescopes 1.

The users, connected by means of the wide-area data network to the global area network 11, access request management systems and reply management systems which are connected to the main software program 20, which has a control supervisor 21 and allows the user to send the requests for use of a given telescope 1 or of an image acquisition device 10.

The operation of the device according to the invention is now described with reference to Figure 4.

In practice, each electronically-controlled telescope 1 is, as shown, connected to a computer 2 which controls it, and each one of said computers 2 is included in the context of a local network 3. A server  $S_1$  is part of the local network 3 and deals with receiving from the global area network 11 (for example the Internet) the requests of the users in real time and with converting them into a suitable language which can be understood by the computers 2 that control the telescopes 1.

The server  $S_1$  then transmits the necessary instructions to the control computers 2, waits for the results (for example images from the CCD acquisition devices), converts them to an appropriate form and transmits them, again by means of the global area network 11, to the users.

In detail, therefore, the main program provides for a step 25 for waiting for requests from the management system, i.e., from the server, which following a request 26 submitted by a user by means of the global area network 11 decodes the request, step 27, a step 28 for managing the control computers 1, and a step 29 for sending the request thus decoded to the control computers 1 by means of the local area network 3.

Each computer reports, by means of the network 3, its situation, step 30, and during step 31 the reply to the request 26 submitted by the user is downloaded from the computer 2.

The reply thus downloaded is prepared, step 32, to be sent by means of the global area network 11 to the user as a reply 33.

The reply thus prepared is also stored in the database for future use.

In practice, each user, by means of a connection to a global area network  
5 such as for example the Internet, can access a chosen telescope and can take control of it, from his own location, by keying in commands which are interpreted as commands for aiming the telescope, taking still pictures or moving pictures by means of the CCD acquisition devices.

The images captured by the telescope are then displayed in real time on  
10 the computers of the users.

This eliminates the need for users to purchase their own telescope, which is usually very expensive if one wishes to have a significant performance, and also eliminates the need to travel to a suitable location for the intended astronomical observation.

15 It should also be noted that the user is able to choose the telescope he prefers, taking also into account the weather conditions. If the chosen telescope is not able to make observations owing to the weather (for example clouds or other conditions), the user can always choose to use another telescope among the ones available and connected in a network,  
20 accordingly utilizing the time available in the best possible way.

Moreover, conventional telescopes are highly sensitive to temperature changes, which induce, in the materials of which they are made, size variations according to the ability of the materials to absorb and/or transmit the received heat. Metals are materials which are particularly sensitive to  
25 these phenomena and tend to expand and contract very easily also for small temperature variations. The telescope used in the process according to the invention provides for the use of optical glass which has a much better intrinsic resistance to thermal expansion than currently available telescopes.

A glass-ceramic material is in fact used for the optical elements which is  
30 approximately 60 times more resistant to temperature variations than the

kinds of glass used for the mirrors of conventional telescopes.

An optical element supporting tube made of carbon fiber is coupled to this type of material and, in addition to providing great advantages in terms of agility and light weight, it has a thermal expansion coefficient which is very close to the coefficient of the glass ceramics used for the optical elements. In this manner, the optical tube and the mirrors accommodated inside it are highly insensitive to ambient temperature variations and in any case the glass ceramic material that forms the mirror and the tube in which said mirror is accommodated react uniformly to such variations. The result is that focusing operations are highly facilitated, positions remain extremely stable over time and require a very small number of corrections, differently from what occurs for conventional telescopes, where focusing does not hold for more than a few hours per night.

This allows absolute remotization of the telescopes used in the device and in the process according to the invention, with the advantage of being able to completely eliminate the physical presence of an operator assigned to the constant focusing of the telescope.

Moreover, as shown in Figure 5, the telescope used in the device and process according to the invention has a variable focal length system, according to the requirements of the object to be photographed.

Conventionally, conventional telescopes have a fixed focal length which has to be replaced in order to modify the performance of the telescope, with a complicated operation which most of all obviously requires the presence of an operator.

The presence of a variable focal length system, obtained as described hereafter, instead allows to have a chosen focal length according to the requirements of the object to be photographed or recorded in motion.

Figure 5 is a view of a telescope 1 which is formed by a footing 50 on which a tube 60 is pivoted which internally accommodates the optical elements and a CCD device, designated by the reference numeral 65.

Differently from conventional telescopes, in which the CCD device is of the fixed-focus type, the telescope according to the invention has a CCD device 65 which is suitable to move so as to be able to vary the focus of the telescope. This translatable motion is achieved by using a tube 70 which is arranged coaxially outside the tube 60 and can move along guides on the outer surface of the tube 60, so that the CCD device 65, rigidly coupled to the tube 70, can perform a translatable motion with respect to the tube 60. This translatable motion therefore allows to modify the focus of the telescope without having to use a single focal length for each telescope.

10 This refinement allows the remotization of the telescopes used in the process according to the invention to be absolute even as regards focusing said telescopes in addition to their aiming.

The above-described control device and process are susceptible of numerous modifications and variations, all of which are within the scope of the inventive concept. Thus, for example, the global area network can be a satellite network. All the details may also be replaced with other technically equivalent elements.

The disclosures in Italian Patent Application No. MI98A002104 from which this application claims priority are incorporated herein by reference.

### CLAIMS

1. A device for remote control of telescopes for astronomical observations, characterized in that it comprises one or more telescopes, each controlled by a respective computer, at least one server to which said  
5 computers are connected by means of a local area network, said server being connected to a wide-area data network in order to receive requests from users to access said one or more telescopes, said server decoding said requests and transmitting to said control computers the instructions required to actuate said telescopes according to the requirements of the users.
- 10 2. The device according to claim 1, characterized in that each one of said computers is provided with software for controlling the respective telescope.
3. The device according to claim 1, characterized in that it comprises at least one video acquisition device associated with each one of said telescopes.
- 15 4. The device according to one or more of the preceding claims, characterized in that it provides for a plurality of servers, at least one telescope being associated with each one of said servers.
5. The device according to one or more of the preceding claims, characterized in that said computers are connected to the respective  
20 telescopes by means of a serial connection.
6. The device according to one or more of the preceding claims, characterized in that each one of said telescopes comprises a first tube which is adapted to accommodate a CCD device and is rigidly coupled to a second tube which is arranged coaxially to the first tube, said second tube  
25 being movable along the outer surface of said first tube in order to vary the position of said CCD device.
7. A process for remote control of telescopes for astronomical observations, characterized in that it comprises the steps of:  
    sending to a server, by means of a wide-area data network, a request to  
30 use a remote telescope;

waiting for said server to enable said telescope; and  
waiting for the response of said telescope, in terms of images,  
photographs and the like from said server.

8. The process according to claim 7, characterized in that it comprises, at  
s said server, a database for storing images acquired by the telescope  
associated with said server.

9. The process according to claim 7, characterized in that said server  
sends the required information to the user by means of said wide-area data  
network.

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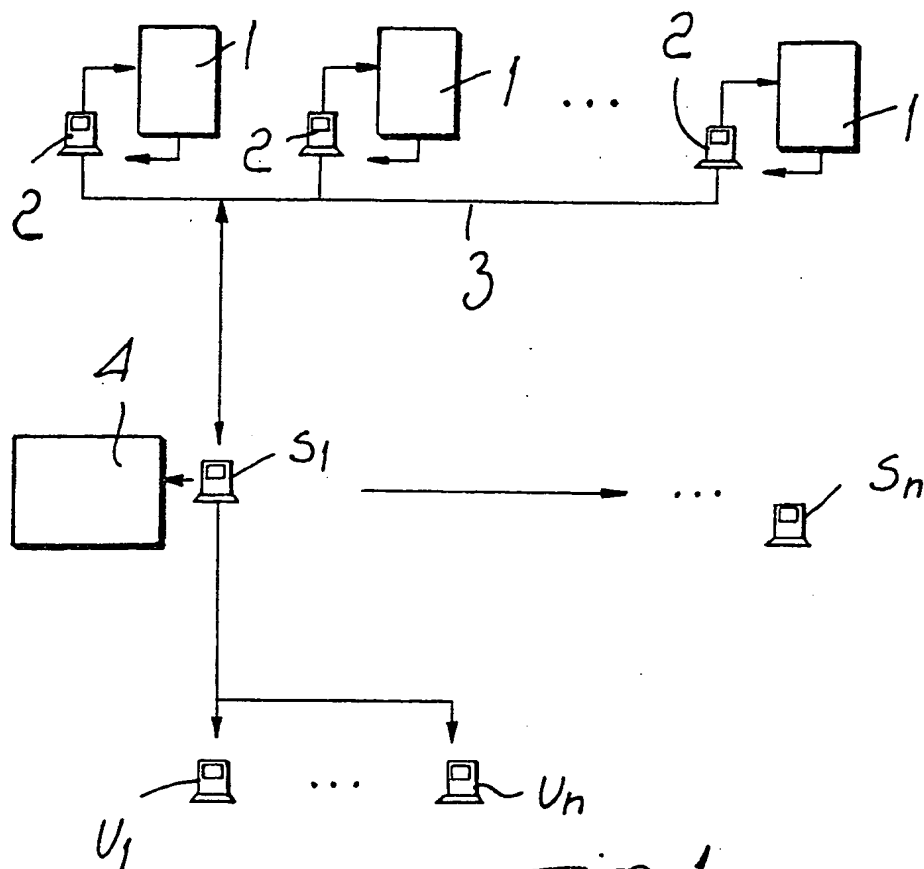


Fig. 1

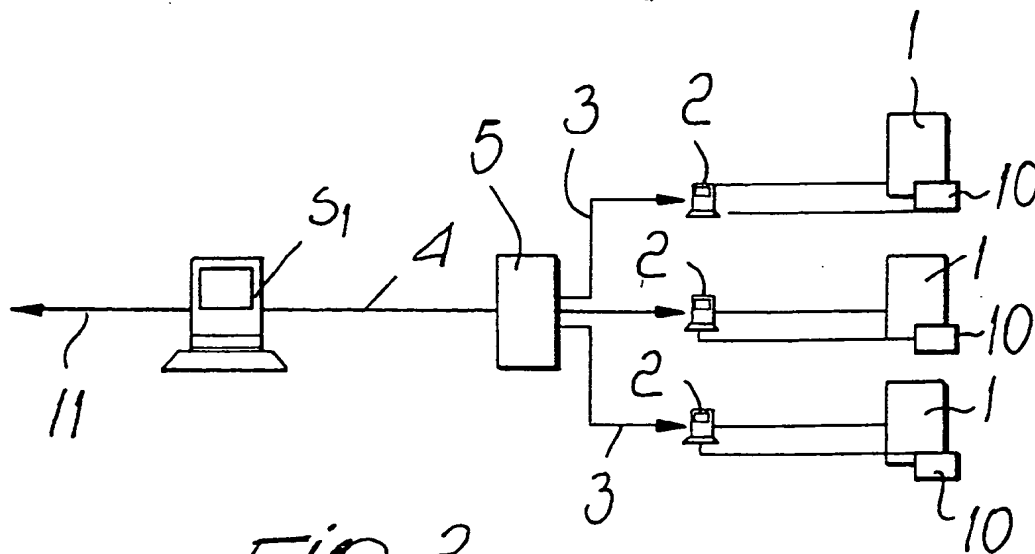
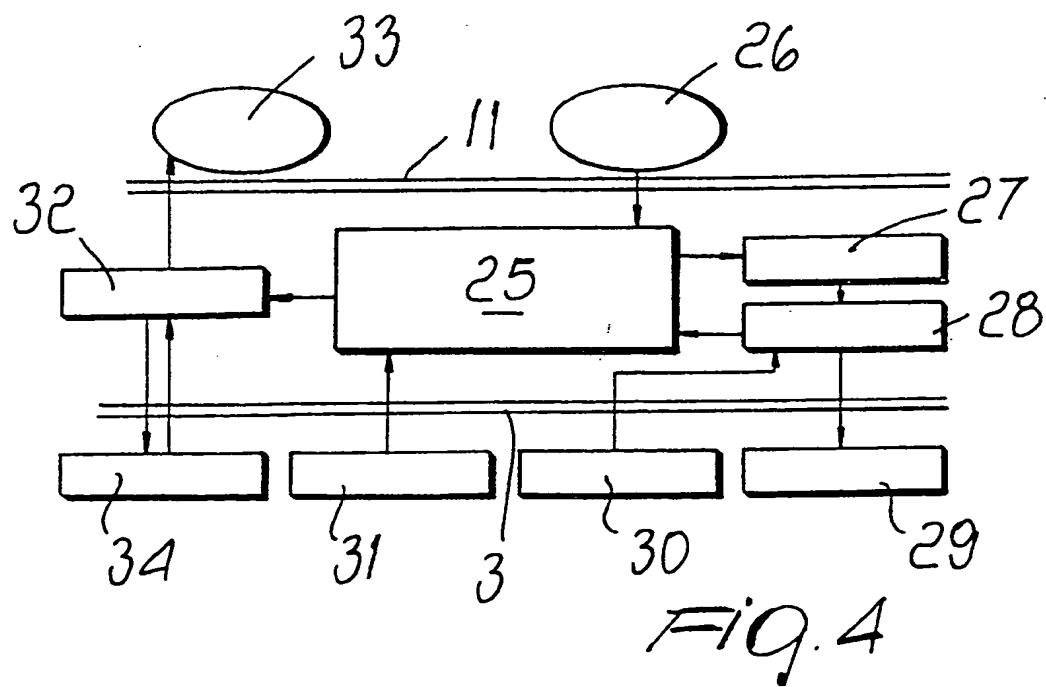
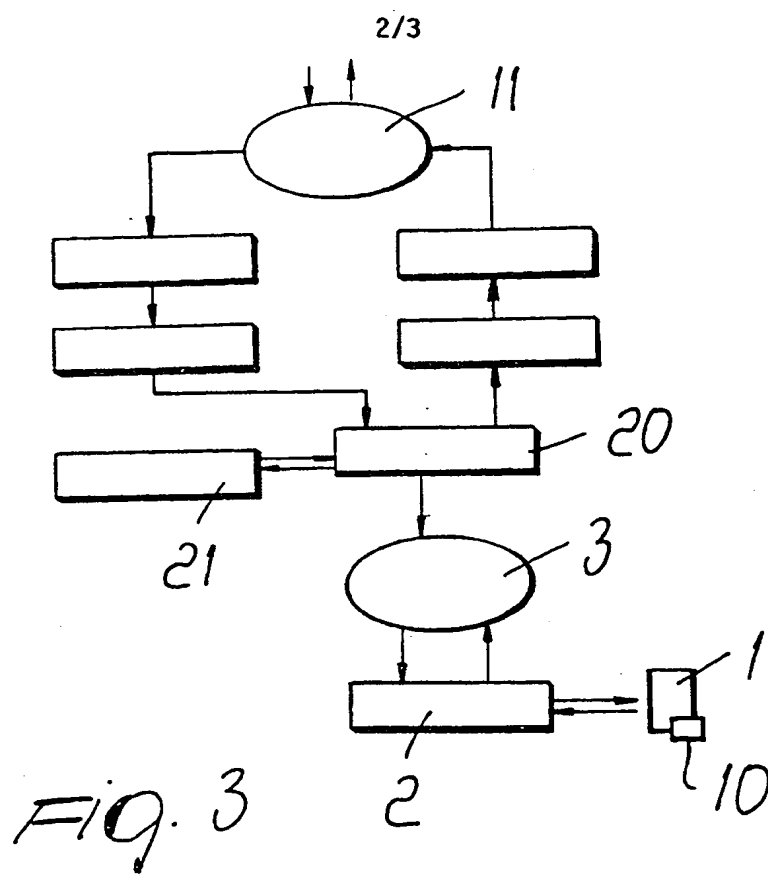
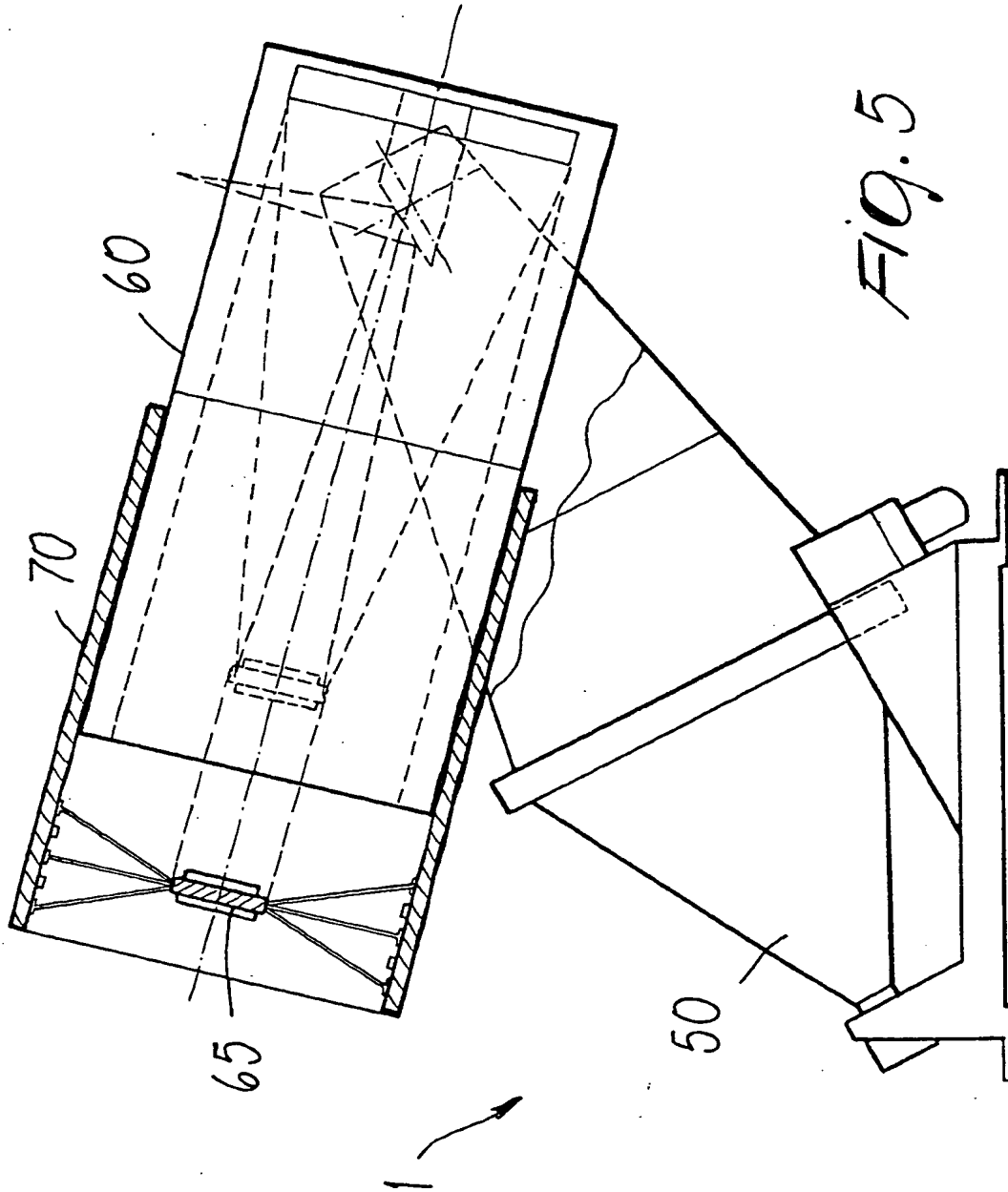


Fig. 2





## INTERNATIONAL SEARCH REPORT

International Application No

PCT/IB 99/01592

A. CLASSIFICATION OF SUBJECT MATTER  
IPC 7 H04M11/00 H04L12/28

According to International Patent Classification (IPC) or to both national classification and IPC

## B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC 7 H04M H04L

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

## C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	BARUCH J E F ET AL: "REMOTE CONTROL AND ROBOTS: AN INTERNET SOLUTION" COMPUTING & CONTROL ENGINEERING JOURNAL, GB, STEVENAGE, vol. 7, no. 1, page 39-45 XP000614098 page 41, right-hand column -page 44, right-hand column, line 23 -----	1-9

☐ Further documents are listed in the continuation of box C.

☐ Patent family members are listed in annex.

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